respectfully request reconsideration of the rejections set forth in the Office Action dated May 9, 2002 in view of the following remarks.

Applicants thank the Examiner for the courtesy extended during the telephonic interview with Applicants' representative on July 30, 2002. During that interview, recent electroactive polymer advances were demonstrated and discussed via several videos.

Several of the claims have been amended to clarify the present invention without modifying or limiting claim scope. For example, independent claim 21 now recites "wherein the electroactive polymer has an elastic modulus at most about 100 MPa without electrical energy applied thereto". Support for this amendment is found in the Specification on page 18, lines 15-19, and on page 17, line 10 to page 20, line 8, for example. In addition, independent claims 1, 21, 24, 28, and 33 now recite "an electroactive polymer" instead of a "polymer". Support for this amendment is found throughout the Specification, and particularly from page 17, line 10 to page 18, line 33 and to page 10, line 35 to page 22, line 19, for example.

Rejections Under 35 U.S.C. § 103(a)

Claims 1-36 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,401,911 to Ravinet et al. ("Ravinet '911") in view of U.S. Patent No. 3,832,580 to Yamamuro et al. ("Yamamuro"). Applicants respectfully disagree.

Ravinet '911 describes a an active suspension piezoelectric device. Yamamuro describes a high molecular weight, thin film piezoelectric device.

The Office Action rejected the claims using piezoelectric ceramics prior art (Ravinet '911 and Yamamuro). Piezoelectric ceramics are rigid solids with an elastic modulus over 100 MPa and limited to strains typically less than 1%. The compliant electroactive polymers of the present invention are materials outside the scope of rigid piezoelectric ceramics. Applicants respectfully submit that one of skill in the art is aware of the many materials and performance differences between electroactive polymers and rigid piezoelectric ceramics, and would not use the two interchangeably. For example, many electroactive polymers of the present invention have an elastic modulus well under 100 MPa and are often capable of strains over 30%. The Specification provides several exemplary electroactive polymers having a high strain and low modulus on page 15, lines 8-21 and page 18, lines 13-25. Thus, Applicants respectfully submit that piezoelectric ceramics prior art cannot be used, either alone or in combination, to teach the present invention.

Each of the independent claims also present limitations that each further distinguish the independent claims from the prior art of record. For example, amended independent claim 1 recites "wherein a second portion of the electroactive polymer is elastically pre-strained". Elastic pre-strain of a compliant electroactive polymer is described in the Specification on page 13, line 27 to page 15, line 8. The art of record does not teach or suggest pre-straining an electroactive polymer used in a generator.

In addition, amended independent claim 21 recites "wherein the electroactive polymer has an elastic modulus at most about 100 MPa without electrical energy applied thereto". The art of record does not teach or suggest polymers under 100 MPa.

Amended independent claim 24 recites "a frame attached to a second portion of the polymer, the frame comprising at least one aperture, wherein the first portion of the polymer is arranged in a manner which causes a change in electric field in response to a deflection applied to a third portion of the polymer". The art of record does not teach or suggest such a limitation.

Amended independent claim 24 recites "a frame attached to a second portion of the polymer, the frame comprising at least one aperture, wherein the first portion of the polymer is arranged in a manner which causes a change in electric field in response to a deflection applied to a third portion of the polymer". The art of record does not teach or suggest a frame comprising at least one aperture attached to a portion of an electroactive polymer.

For at least these reasons, Applicants respectfully submit that independent claims 1, 21, 24, 28 and 33 are not anticipated by the art of record, and are patentably distinct.

Claims 2-20, 22-23, 25-27, 29-32 and 34-36 each depend either directly from independent claims 1, 21, 24, 28 and 33, respectively, and are therefore respectfully submitted to be patentable over the art of record for at least the reasons set forth above with respect to the independent claims. Further, the dependent claims recite additional elements which when taken in the context of the claimed invention further patentably distinguish the art of record.

For example, dependent claim 5 recites "wherein electrical energy is removed by the at least two electrodes during the contraction". As detailed the Specification on page 13, lines 16-26 and page 12, line 17 to page 13, line 15, for example, removing electrical energy as the electroactive polymer contracts may avoid a situation in which electrical based mechanical pressure within the polymer is sufficient to prevent further elastic contraction of the electroactive polymer; and thus allows increased electrical energy generation from a given mechanical input. It is respectfully submitted that the piezoelectric ceramic prior art of record does not teach such a limitation.

Dependent claim 9 recites "wherein the polymer has a maximum linear strain of at least about 50 percent". Piezoelectric ceramics are rigid solids are generally limited to strains less than 1%. The prior art of record does not teach or suggest a generator as recited in claim 9.

For at least these reasons, withdrawal of the rejection under 35 U.S.C. § 103(a) is respectfully requested.

Conclusion

In view of the foregoing, Applicant believes that all pending claims are allowable and respectfully requests a Notice of Allowance from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the number set out below. If any fees are due in connection with the filing of this paper, the Commissioner is authorized to charge such fees to Deposit Account 50-0388 (Order No. SRI1P022).

Respectfully submitted,
BEYER WEAVER & THOMAS, LLP

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Claims:

1. (Once Amended) A generator for converting mechanical energy to electrical energy, the generator comprising:

at least two electrodes; and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection applied to a first portion of the electroactive polymer, wherein a second portion of the electroactive polymer is elastically pre-strained.

8. (Once Amended) The generator of claim 1 wherein the electroactive polymer has a substantially constant thickness before deflection and the deflection comprises a decrease in net area of the polymer orthogonal to the thickness.

21. (Once Amended) A generator for converting mechanical energy to electrical energy, the generator comprising:

at least two electrodes; and

an electroactive polymer [having a substantially constant thickness and an area orthogonal to the thickness, the polymer] arranged in a manner which causes a change in electric field in response to a net area decrease of the polymer for the area orthogonal to the thickness, wherein the electroactive polymer has an elastic modulus at most about 100 MPa without electrical energy applied thereto.

24. (Once Amended) A generator for converting from electrical energy to mechanical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection applied to a first portion of the polymer; and

a frame attached to a second portion of the polymer, the frame comprising at least one aperture, wherein the first portion of the polymer is arranged in a manner which causes a change in electric field in response to a deflection applied to a third portion of the polymer.

28. (Once Amended) A generator for converting mechanical energy in a first direction into electrical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection in the first direction; and

a flexible frame coupled to the polymer, the frame providing improved conversion from mechanical to electrical energy for the at least one transducer.

33. (Once Amended) A generator for converting mechanical energy in a first direction into electrical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection in the first direction; and

at least one stiff member coupled to the at least one transducer, the at least one stiff member substantially preventing displacement in a second direction.

APPENDIX OF PENDING CLAIMS

1. (Once Amended) A generator for converting mechanical energy to electrical energy, the generator comprising:

at least two electrodes; and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection applied to a first portion of the electroactive polymer, wherein a second portion of the electroactive polymer is elastically pre-strained.

2. The generator of claim 1 wherein the generator is stretched before the deflection.

3. The generator of claim 2 wherein the at least two electrodes apply a voltage that produces a pressure in the polymer less than elastic restoring stresses resulting from the stretch.

4. The generator of claim 2 wherein the deflection is a contraction in one direction.

5. The generator of claim 4 wherein electrical energy is removed by the at least two electrodes during the contraction.

6. The generator of claim 1 wherein the polymer has an elastic modulus below about 100 MPa.

7. The generator of claim 1 further comprising a mechanical input that provides the deflection and mechanical energy.

8. (Once Amended) The generator of claim 1 wherein the electroactive polymer has a substantially constant thickness before deflection and the deflection comprises a decrease in net area of the polymer orthogonal to the thickness.

9. The generator of claim 1 wherein the polymer has a maximum linear strain of at least about 50 percent.

10. The generator of claim 9 wherein the polymer has a maximum linear strain of at least about 100 percent.

11. The generator of claim 1 wherein the polymer has a maximum area strain of at least about 100 percent.

12. The generator of claim 1 wherein the pre-strain is applied to a first orthogonal direction at a pre-strain greater than pre-strain in a second orthogonal direction.

13. The generator of claim 12 wherein the pre-strain applied to the first orthogonal direction is used to enhance the change in electric field from a deflection in the second orthogonal direction.

14. The generator of claim 12 wherein the polymer is pre-strained by a factor in the range of about 1.5 times to 50 times an original area prior to pre-strain.

15. The generator of claim 1 further comprising an electric circuit electrically coupled to the at least two electrodes.

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16. The generator of claim 1 wherein the polymer comprises a material selected from the group consisting of silicone elastomer, acrylic elastomer, polyurethanea copolymer comprising PVDF, and combinations thereof.

17. The generator of claim 1 wherein the polymer can support a change in electric field at most about 440 MegaVolts/meter.

18. The generator of claim 1 wherein electrical energy generated by deflection of the polymer generates at least about 0.15 Joules per gram for the polymer.

19. The generator of claim 1 wherein the generator is used in a heel strike generator.

20. The generator of claim 1 wherein one of the at least two electrodes is compliant.

21. (Once Amended) A generator for converting mechanical energy to electrical energy, the generator comprising:

at least two electrodes; and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a net area decrease of the polymer for the area orthogonal to the thickness, wherein the electroactive polymer has an elastic modulus at most about 100 MPa without electrical energy applied thereto.

22. The generator of claim 21 wherein the generator is stretched before the change in electric field.

23. The generator of claim 22 wherein the at least two electrodes apply a voltage that produces a pressure in the polymer less than the elastic restoring forces resulting from the stretch.

24. (Once Amended) A generator for converting from electrical energy to mechanical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection applied to a first portion of the polymer; and

a frame attached to a second portion of the polymer, the frame comprising at least one aperture, wherein the first portion of the polymer is arranged in a manner which causes a change in electric field in response to a deflection applied to a third portion of the polymer.

25. The generator of claim 24 wherein the transducer is stretched before deflection of the third portion of the polymer

26. The generator of claim 25 wherein the at least two electrodes apply a voltage that produces a pressure in the polymer less than elastic restoring stresses resulting from the stretch.

27. The generator of claim 26 further including a bias pressure.

28. (Once Amended) A generator for converting mechanical energy in a first direction into electrical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection in the first direction; and

a flexible frame coupled to the polymer, the frame providing improved conversion from mechanical to electrical energy for the at least one transducer.

29. The generator of claim 28 wherein the transducer is stretched before the change in electric field.

30. The generator of claim 28 wherein the at least two electrodes apply a voltage that produces a pressure in the polymer less than the elastic restoring stresses resulting from the stretch.

31. The generator of claim 28 wherein the polymer comprises pre-strain.

32. The generator of claim 31 wherein the polymer comprises pre-strain in a second direction which improves energy conversion in the first direction.

33. (Once Amended) A generator for converting mechanical energy in a first direction into electrical energy, the generator comprising:

at least one transducer, each transducer comprising:

at least two electrodes, and

an electroactive polymer arranged in a manner which causes a change in electric field in response to a deflection in the first direction; and

at least one stiff member coupled to the at least one transducer, the at least one stiff member substantially preventing displacement in a second direction.

34. The generator of claim 33 wherein the polymer has a compliance in one direction greater than in a second.

35. The generator of claim 33 wherein the polymer has an aspect ratio of at least 4:1.

36. The generator of claim 33 wherein the at least one stiff member is coupled to an edge of the polymer.